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(54) **Variable nozzle turbocharger.**

(57) A variable nozzle turbocharger has a ring of vanes (34, 134) mounted within the annular passageway (30) through which exhaust gases flow from a volute (28) to the turbine rotor (12). The vanes (34) can pivot on pins (36) mounted in axial bores in a nozzle ring (38) which defines one side of the passageway (30) and is secured to the housing by dowels (55) or bolts (141). The free ends of the vane pins (36) are secured to respective vane arms (46) which have outer ends which can rock in slots (51) on the radially inner surface of a unison ring (48). The unison ring is mounted on rollers (49) on dowels (55) located in relation to the housing and the nozzle ring (38) and can be turned around the nozzle ring (38) by an external crank mechanism (60) to pivot all the vanes (34) together to vary the angle at which the exhaust gases are directed at the turbine rotor. The dowel and roller guides maintain the unison ring (48) concentric with the nozzle ring (38) which is itself concentrically located in relation to the housing.

EP 0 226 444 A2

Description

VARIABLE NOZZLE TURBOCHARGER

The present invention relates to turbomachinery and more particularly to an improved suspension design for the pivoting vane actuation mechanism of a variable nozzle turbocharger.

In turbomachinery in which the turbine is intended to drive a compressor or the like, it is often desirable to control the flow of motive gas to the turbine to improve its efficiency or operational range. In order to accomplish this, the nozzle passages leading to the turbine wheel may be of variable geometry. These variable geometry nozzle passages can be provided by means of a plurality of vanes which are pivotable so as to alter the configuration of the passages therebetween. The design of the suspension system used in association with the pivoting vane design is critical to prevent binding of either the suspension system or the vanes.

U.S. Patents Nos. 2,860,827 and 4,179,247 disclose designs to prevent binding of the pivoting vane actuation mechanism. However, none of the above mentioned designs are suspension systems for an actuation system which accommodates the thermal cycling experienced by the turbine housing as well as the components of the actuation system.

In accordance with the present invention a suspension for the pivoting vane actuation mechanism of a variable nozzle mechanism for a turbocharger includes rotatable guide vanes mounted on a nozzle ring within an annular nozzle passageway immediately upstream of the turbine wheel.

A unison ring is mounted to rotate to cause pivoting of the vanes, on a mounting which maintains concentricity between the nozzle ring and the unison ring.

In a preferred arrangement, the nozzle ring is aligned with the turbocharger housing via dowels extending between the two. These dowels also serve to carry rollers thereon. The rollers provide a surface on which the periphery of the unison ring rides.

The invention tends to eliminate binding of the variable nozzle system, and maintains the unison ring and nozzle ring concentrically aligned during operation.

The nozzle ring is continuously aligned with the turbine side wall to provide an annular passage with a constant width.

The invention may be carried into practice in various ways, and two embodiments will be described by way of example with reference to the accompanying drawings, in which:-

Figure 1 is a diagrammatic view illustrating a turbocharged engine system;

Figure 2 is a cross-sectional view of the internal components of an exhaust gas turbocharger;

Figure 3 is a sectional view of the turbine end of the turbocharger which illustrates the present invention;

Figure 4 is a partial sectional view of the turbine end of the turbocharger taken along line

4-4 of Figure 3;

Figure 5 is a perspective view of the flange member;

Figure 6 is a perspective view of the assembled nozzle ring and unison ring;

Figure 7 is a partial sectional view corresponding to Figure 4 of an alternative embodiment; it is taken on line 7 of Figure 10;

Figure 8 is a partial sectional view taken along line 8 of Figure 10;

Figure 9 is a partial sectional view taken along line 9 of Figure 10;

Figure 10 is a partial end view of the nozzle ring of the alternative embodiment; and

Figure 11 is a partial sectional view taken along line 11 of Figure 10.

An engine system as shown in the Figures 1 to 3 includes turbomachinery in the form of a turbocharger 10 generally comprising a turbine wheel 12 and a compressor impeller 13 mounted on opposite ends of a common shaft 16. The turbine wheel 12 is disposed within a turbine housing 18 which includes an inlet 20 for receiving exhaust gas from an engine 14 and an outlet 21 for discharging the exhaust gas. The turbine housing 18 guides the engine exhaust gas into communication with and expansion through the turbine wheel 12 for rotatably driving the turbine wheel. Such driving of the turbine wheel simultaneously and rotatably drives the compressor impeller 13 which is carried within a compressor housing 22. The compressor housing 22, including an inlet 23 and outlet 25 and the compressor impeller 13 cooperate to draw in and compress ambient air for supply to the intake of the engine 14.

The turbine housing 18 is mounted to a flange member 24 which, in turn, is mounted to centre housing 26 and could be a part of it. The compressor housing 22 is mounted on the other side of the centre housing 26. The centre housing 26 includes a bearing means 29 for rotatably receiving and supporting the shaft 16. A thrust bearing assembly 33 is carried about the shaft adjacent the compressor housing for preventing axial excursions of the shaft 16. A heat shield 44 is positioned about the shaft 16 at the turbine end in order to insulate the centre housing 26 from the harmful effects of the exhaust gas.

Lubricant such as engine oil or the like is supplied via the centre housing 26 to the journal bearing means 29 and to the thrust bearing assembly 33. A lubricant inlet port 37 is formed in the centre housing 26 and is adapted for connection to a suitable source of lubricant such as filtered engine oil. The port communicates with a network of internal supply passages which are formed in the centre housing 26 to direct the lubricant to the appropriate bearings. The lubricant circulated to the bearings is collected in a suitable sump or drain for passage to appropriate filtering, cooling, and recirculation equipment, all in a well-known manner.

Figure 4 shows the turbine housing 18 forms a

generally scroll-shaped volute 28 which accepts the exhaust gas from the engine 14 and directs it onto the blades of the turbine wheel 12 through an annular passage 30. Thereafter, the exhaust gas flows axially through the turbine shroud 32 and exits the turbocharger through outlet 21 either into a suitable pollution-control device or the atmosphere. Placed within the annular passage way 30 are a plurality of pivotable vanes 34 which operate to vary the geometry of the annular passage 30 to control the angle at which the exhaust gas impacts the blades of the turbine wheel 12. This in turn controls the amount of energy imparted to the compressor wheel and ultimately the amount of air supplied to the engine.

The flange member 24 and the turbine housing 18 form between them a cavity 27 which houses the hardware used in conjunction with the variable geometry turbine to be described below. The annular passage 30 for the exhaust gas is defined between the inner side wall 31 of the turbine housing 18 and an annular nozzle ring 38. Located circumferentially around and within the annular passage 30 are a plurality of vanes 34. Each vane 34 is mounted to be capable of pivoting on the nozzle ring 38 on a vane pin 36 which can turn in a bore in the nozzle ring. Attached by welding to the outer end of each vane pin is a vane arm 46, the shape of which can best be seen in Figure 3. The nozzle ring is between each vane and its vane arm.

Located within passage 30 are a plurality of spacers 86. As shown in Figures 4 and 6, spacers 86 are located at the periphery of the plurality of vanes. They have an axial length (within the range of 0.005 to 0.015 cm) longer than the vane length. The spacers are press fitted in bores formed in the nozzle ring 38, though other methods could be used.

An annular unison ring 48 has a plurality of slots 51 on its inner radial surface, each of which receives a vane arm 46. At the inner periphery of the unison ring 48 are located at least three circumferentially spaced rollers 49. Rollers 49 are rotatably mounted on dowels 55 radially inwardly of the unison ring and with respective ends secured in bores in the flange member 24 and the nozzle ring 38. Dowels 55 have some axial clearance within these bores in order to allow nozzle ring 38 slight axial movement. Rollers 49 include an annular groove 59 therearound for acceptance of the inner periphery of the unison ring 48. Dowels 55 and rollers 49 could be provided additionally at the periphery of the unison ring 48 if so desired. The dowels 55 shown in Figure 4, not only provide a mounting for the unison ring; they also hold and concentrically locate the nozzle ring 38 and prevent it from rotating.

The rollers 49 provide for ease of rotation of the unison ring 48 relative to the flange member 24 and together with dowels 55 ensure the concentricity between unison ring 48 and nozzle ring 38. The shape of the vane arms 46 as seen in Figure 3 must be such as to maintain basically a rolling action within slots 51 to avoid binding within unison ring 48 as it rotates to pivot vanes 34.

The flange member 24 includes a recessed portion for acceptance of the actuation system as

will be described below. Formed in flange member 24 is a shoulder 72 which acts in cooperation with belleville spring 40. The inboard side (on the left in Figure 4) of the radially outer edge of spring 40 rests against the shoulder 72, and when assembled, the opposite side of the radially inner edge of the spring acts against the shoulder portion 39 of the nozzle ring 38 such that it loads the nozzle ring 38 and the spacers 86 against the turbine side wall 31. Shoulder 72 is continuous about flange 24 with the exception of a break to make room for the bell crank system defined below.

A tube member 42 which is generally cylindrically shaped with an annular bend therein, is slidably engageable within the inner radial surface of the nozzle ring 38. The tube member 42 acts as a seal in the event that any exhaust gas leaks behind the nozzle ring 38 and into the cavity 27 formed between the flange 24 and the turbine housing 18, thereby sealing the turbine housing 18 from the centre housing 26.

In order to rotate the unison ring 48 between its two extreme positions which correspond to the limits of the geometry of the annular passage 30, a bell crank system is used. A pin 50 is rigidly connected to a first linkage member 54 at one end thereof. The pin 50 fits within a corresponding slot 92 within the unison ring 48 in order to transmit any movement in the bell crank to the unison ring 48. The first linkage member 54 is rigidly connected at its other end to a rod member 56. The rod 56 projects through a bore 57 in the flange member 24 to a point outside the turbocharger assembly. Bushing 58 is used in association with rod 56. The rod 56 is rigidly connected at its other end to a second linkage member 60 which in turn is connected to an actuator 90, shown in Figure 1. The actuator shown is a vacuum boost type which is well known in the art. Furthermore, it is envisioned that other actuator means can be used to control the movement of the vanes.

During operation, movement of the second linkage member 60 is translated into movement of the first linkage member 54 via rod 56. The existence of pin 50 will translate any movement of the linkage member 54 into rotational movement of unison ring 48. In turn, vane arms 46 roll against the side wall of slots 51 to pivot vanes 34 while nozzle ring 38 remains stationary. Thus, there is a change in the geometry of the plurality of passageways formed between adjacent vanes.

An alternative embodiment of the invention is shown in Figures 7 to 11. Figure 7 is a partial sectional view of the nozzle and unison rings, 138 and 148, respectively. Parts which correspond with parts in the embodiment of Figures 3 and 4 are given the same reference numerals increased by 100.

In the alternative embodiment the nozzle ring 138 is attached to the turbine housing 118 and defines with it the annular passageway 130, as best shown in Figure 8. Specifically, the nozzle ring 138 is bolted directly to the turbine housing 118 by a ring of bolts 141 and extending within a spacer 143 (Figure 8) which has an axial length slightly longer than the corresponding length of the vanes 134 (Figure 9).

Spacers 134 prevent binding of the vanes as they pivot.

As shown in Figure 9, the vanes are mounted on the nozzle ring 138 by vane pins 136, which can turn in bores in the nozzle ring and are attached at one end to the vanes and at the other end to a vane arm 146. Arm 146 is attached to vane pin 136 by any suitable method of attachment such that the nozzle ring 138 is located between the vane 134 and the vane arm 146.

Figure 10 shows that unison ring 148 is an annular ring with a plurality of slots 151 on its inner radial surface. Each slot receives the outer end of a vane arm 146. Located at the internal periphery of the unison ring 148 are at least three spaced rollers 149. Rollers 149 are rotatably mounted on dowels 155 spaced radially inwardly of the unison ring and secured between the nozzle ring 138 and centre housing 126, each of which has bores for acceptance and location of the dowels. Rollers 149 include an annular groove 159 therearound for acceptance and guidance of the inner periphery of the unison ring. Rollers 149 and dowels 155 ensure the concentricity between the unison ring 148 and nozzle ring 138.

The alternative embodiment has eliminated several elements of the preferred embodiment, i.e. the flange member 24 and tube member 42. Centre housing 126 is different in that it includes a radially outwardly extending flange portion 127 having a bore 157 therethrough for acceptance of the actuation system as shown in Figure 11. Furthermore, the flange portion 127 includes shoulder 135 shaped to mate with the turbine housing 118 and an annular land 147 above the central bore.

As shown in Figure 7, an annular disc 145 is positioned about the turbocharger shaft such that its radially inner edge rests against the land 147 and its radially outer edge rests against a shoulder 139 formed on the inner periphery of nozzle ring 138. Disc 145 functions as a heat shield and seal to prevent heat and exhaust gas leakage around nozzle ring 138.

As best seen in Figure 11, the actuation system is similar to the actuation system in the preferred embodiment except in two respects. Rod 156 and bushing 158 extend through a bore 157 formed in the centre housing 126 as stated above and first linkage member 54 has been replaced by a linkage member 154 which is shaped like a vane arm 146. Linkage member 154 can therefore fit into a slot 151 in unison ring 148 in order to rotate it and the plurality of vanes 134.

Claims

1. A turbocharger in which gas is directed through an annular passage (30, 130) to the turbine, including a ring of guide vanes (34) in the annular passage and pivotally mounted on an annular nozzle ring (38, 138) defining one boundary of the annular passage, and an annular unison ring (48, 148) coupled to pivot

the vanes by movement of the unison ring in relation to the nozzle ring; characterised by a mounting (55, 59) for the unison ring (48) which provides coaxial location between the nozzle ring and the unison ring about the turbine shaft.

2. A turbocharger as claimed in Claim 1, in which the mounting comprises at least three circumferentially spaced dowels (55, 155) extending between the turbocharger housing and the nozzle ring and a roller (49, 159) mounted on each dowel.

3. A turbocharger as claimed in Claim 2, in which the periphery of the unison ring is in rolling contact with the rollers.

4. A turbocharger as claimed in any of the preceding claims, in which the unison ring has a circumferential ring of slots (51), each receiving one end of a vane arm (46), the other end of which is secured to one end of a pin (36) on which a vane (34) is pivotally mounted on the nozzle ring (38).

5. A turbocharger as claimed in any preceding claim, in which the nozzle ring is capable of axial movement in relation to the turbocharger housing.

6. A turbocharger as claimed in Claim 5, including a spring (40) for urging the nozzle ring towards a wall of the turbocharger housing defining the annular passage (30).

7. A turbocharger as claimed in any preceding claim, in which the nozzle ring (138) is mounted from the turbocharger housing.

8. A turbocharger as claimed in any preceding claim, including linkage means (60) mounted in the turbocharger housing and arranged to move the unison ring.

9. A turbocharger as claimed in any preceding claim including spacers (30, 130) between the nozzle ring and the opposite wall of the annular passage which are slightly longer axially than the vanes (34).

10. A turbocharger as claimed in Claim 9, in which the linkage for effecting movement of the unison ring (148) includes a link arm (154) having one end engaging a slot in the periphery of the unison ring (148) and the other end mounted to pivot in the housing (135).

11. A turbocharger as claimed in Claim 9, in which linkage for moving the unison arm includes a rod (56, 156) rotatably mounted in the turbocharger housing and coupled at one end to a link arm (54, 154) coupled to the unison ring and the other end coupled to external adjusting means.

12. In a turbocharger having an exhaust gas driven turbine rotatably mounted to a shaft having a compressor impeller thereon, a compressor housing enclosing said compressor impeller, a centre housing including bearing means for rotatably supporting the shaft, a method of assembling the turbocharger comprising:
mounting a flange member to the centre housing;
pivotally mounting a plurality of vanes to an

annular nozzle ring;
slidably mounting at least three dowels into at
least three bores in said nozzle ring;
slidably and rotatably mounting a roller to each
dowel; 5
mounting, in rolling contact, an annular unison
ring on said rollers;
aligning said dowels with bores formed in the
flange member and sliding the dowel ends
therein; 10
securing a turbine housing defining a volute
therein to the flange member.
13. A method of varying the effective flow area
of an annular passage in an exhaust gas driven
turbocharger comprising the steps of 15
pivotably mounting a plurality of vanes each
having a vane arm to a nozzle ring;
slidably mounting at least three dowels into at
least three bores in said nozzle ring;
slidably and rotatably mounting a roller to each 20
dowels;
rotatably mounting a unison ring on the rollers;
aligning and indexing the vane arms within slots
in the unison ring;
coaxially locating the nozzle ring and unison 25
ring about the turbocharger shaft;
mounting the turbine housing a spaced dis-
tance from the nozzle ring thereby forming the
annular passage; and
pivoting the plurality of vanes in response to 30
operating conditions.

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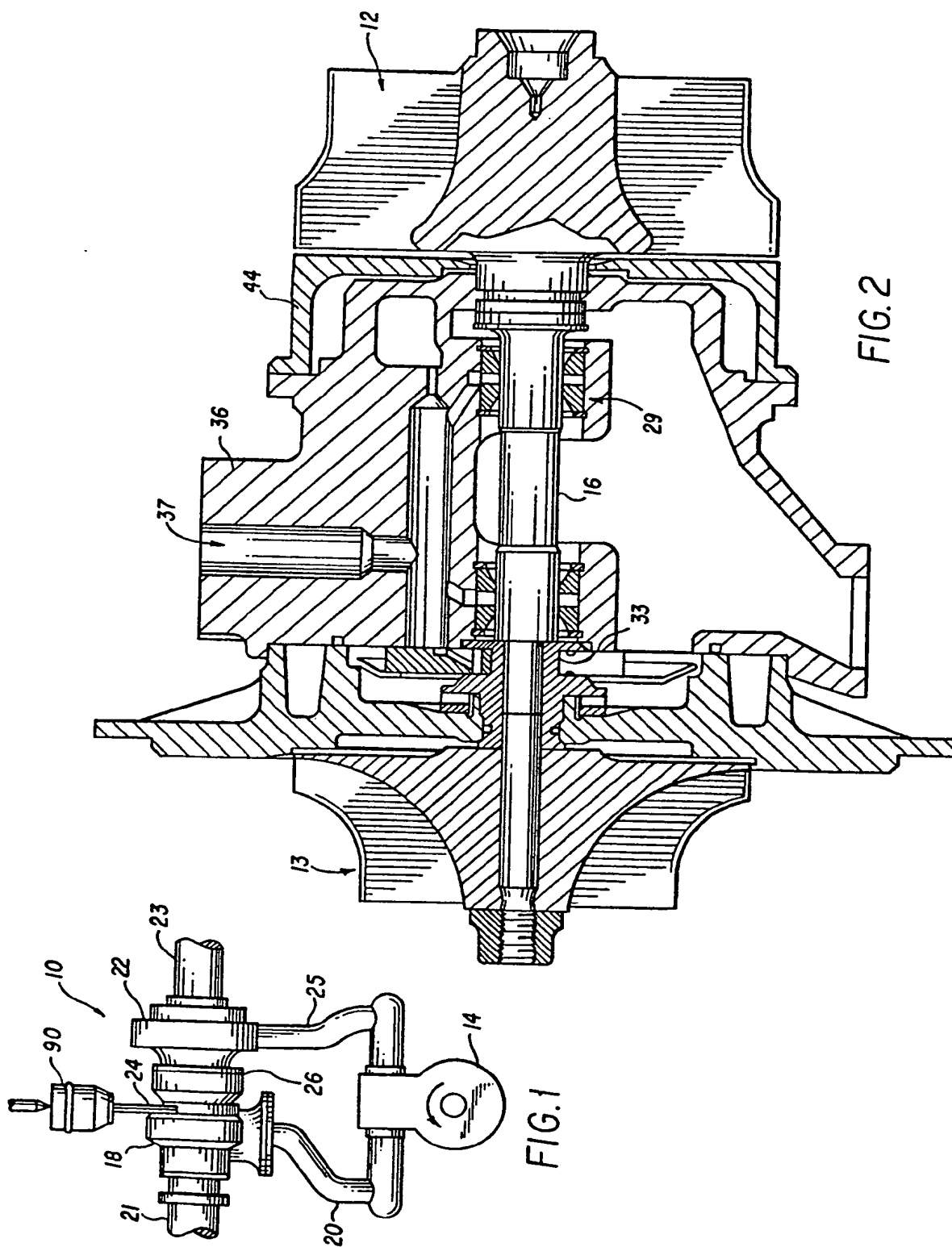
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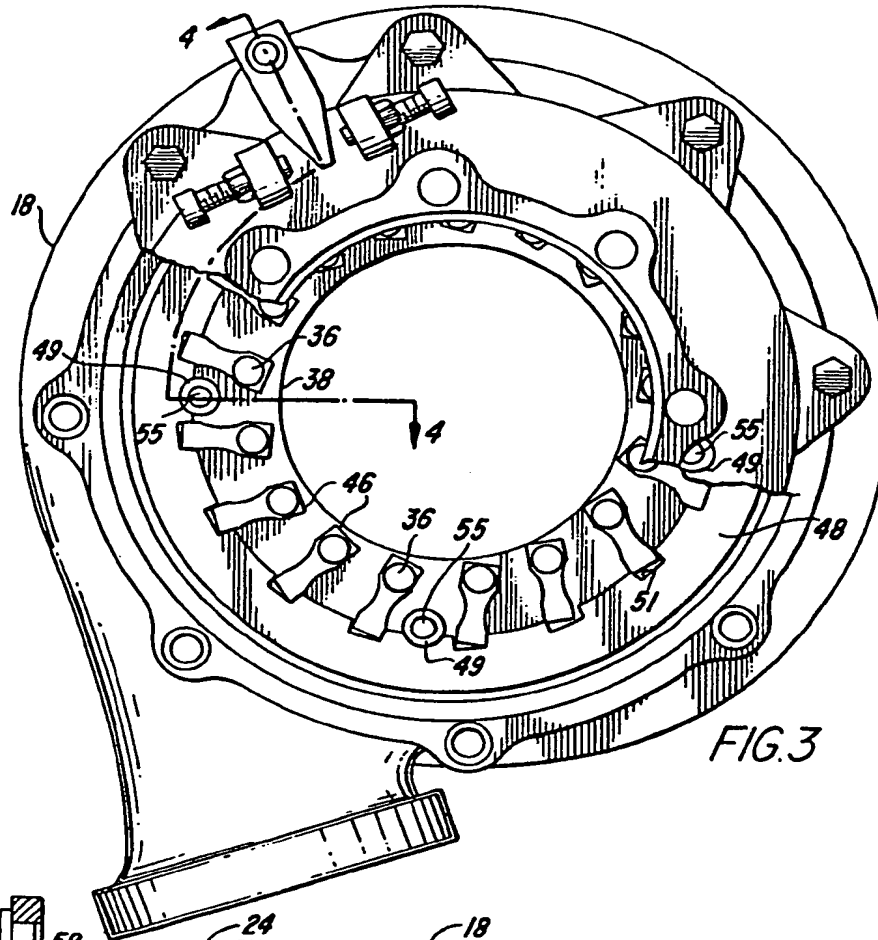


FIG. 3

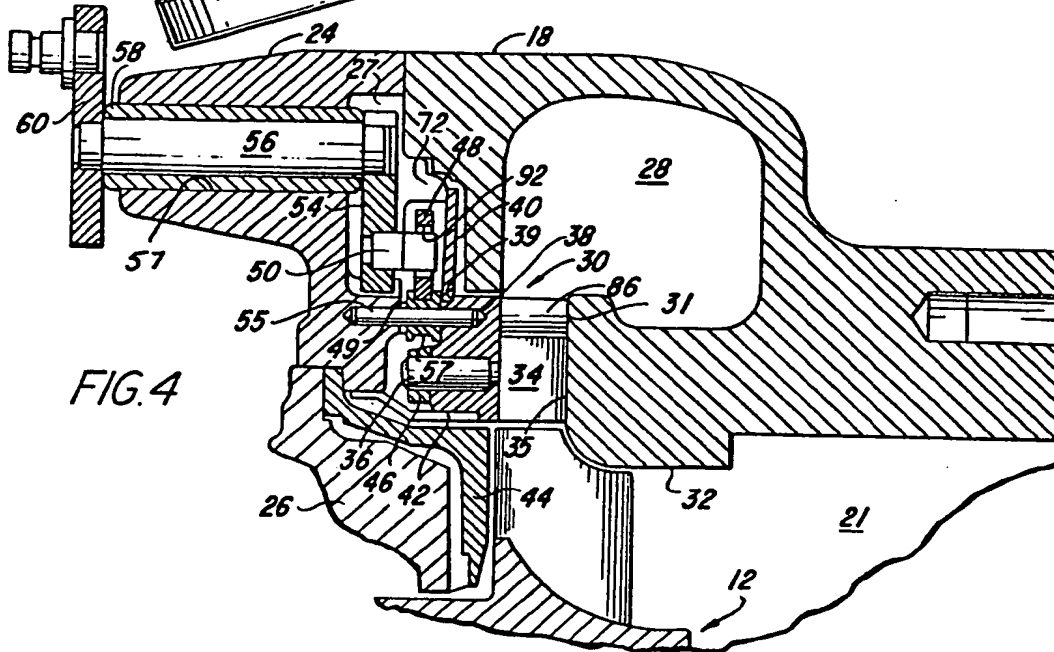
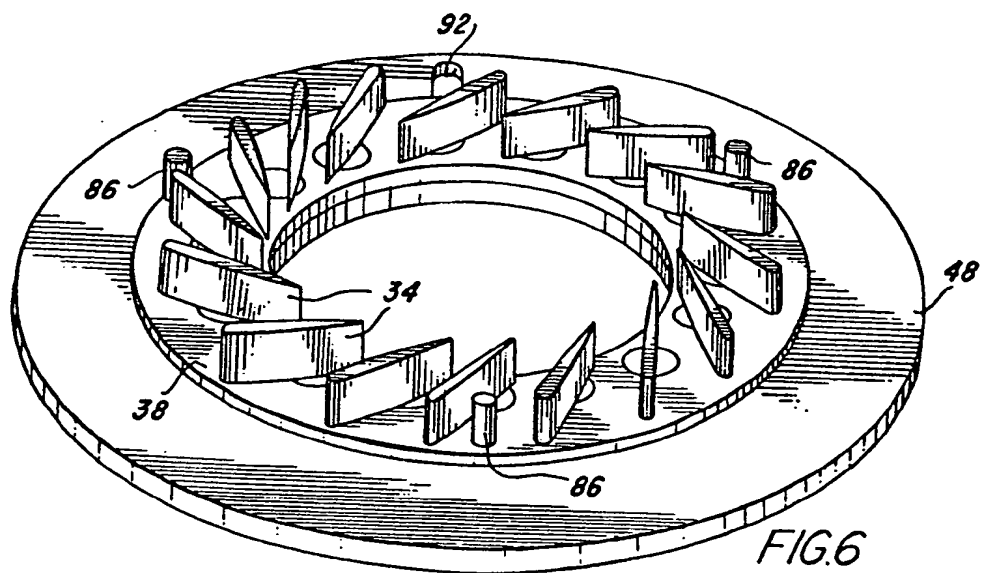
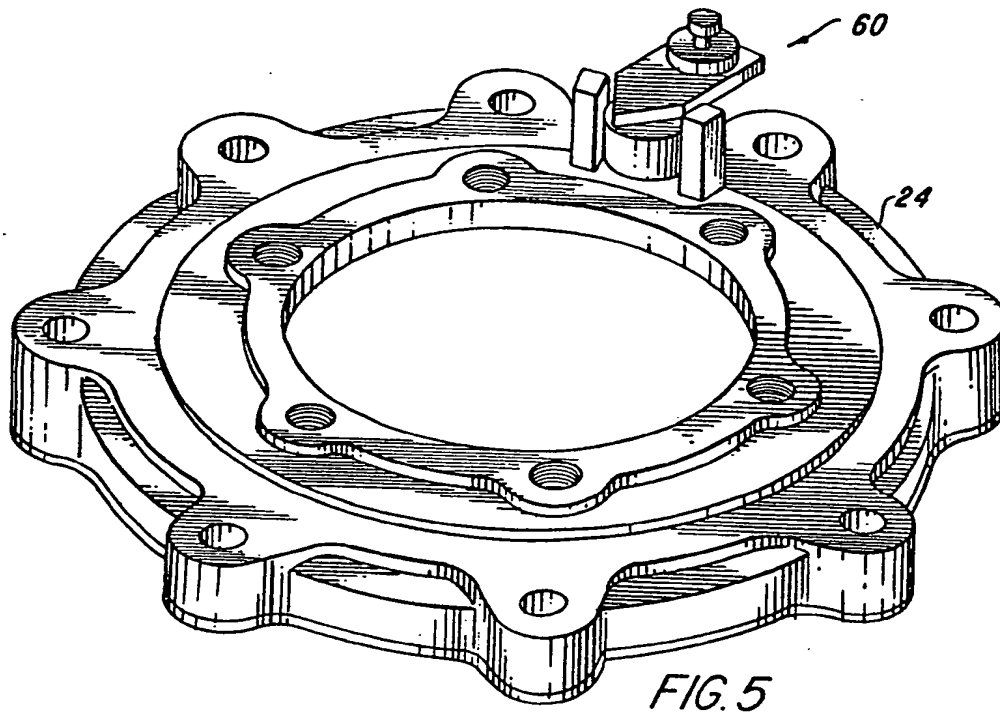
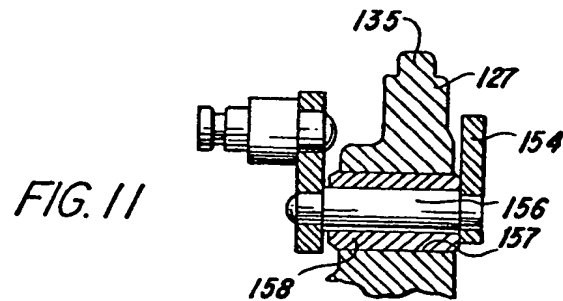
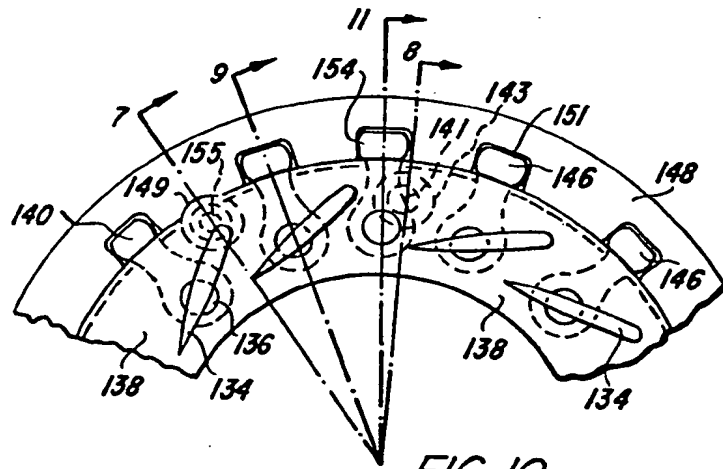
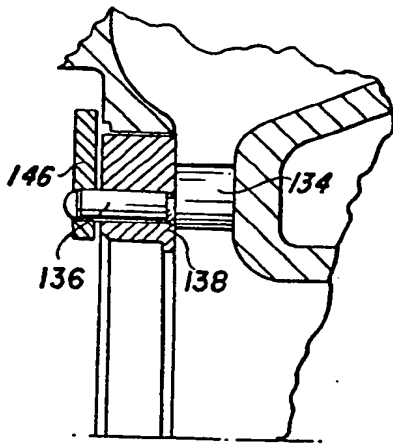
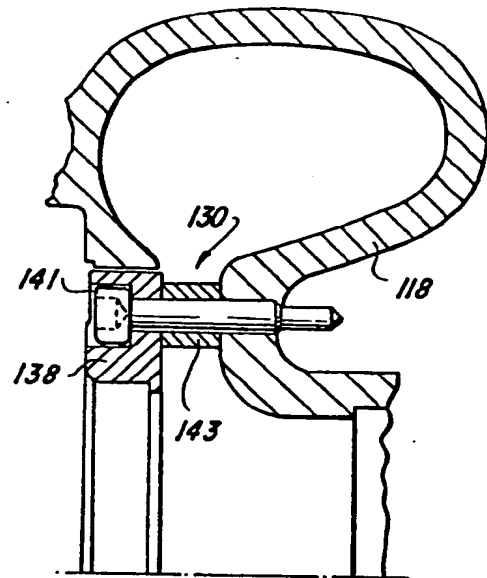
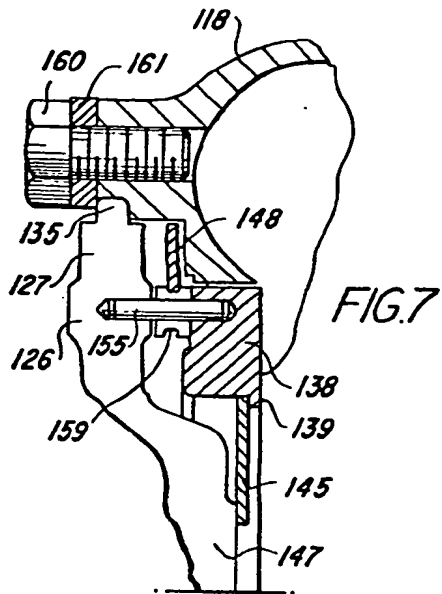


FIG. 4





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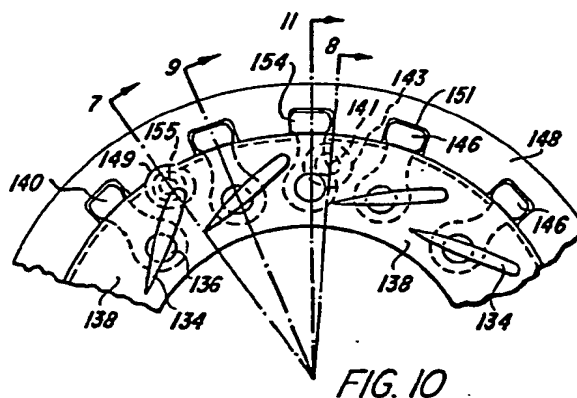
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European Patent
Office

EUROPEAN SEARCH REPORT

Application Number

EP 86 30 9596

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
X	EP-A-0 160 460 (THE GARRETT CORP.) * Page 6, lines 21-35, page 7, lines 2-9; figures 3,5,7 * ---	1-11	F 01 D 17/16 F 02 C 6/12
X	GB-A- 731 822 (POWER JETS (RESEARCH & DEVELOPMENT) LTD) * Page 2, lines 96-117; figure 6 * ---	1-8	
X	US-A-4 502 836 (SWEARINGEN) * Figure 4; column 2, lines 43-45, column 3, lines 23-35 * ---	1-3	
D,A	US-A-4 179 247 (OSBORN) * Whole document * ---	1	
D,A	US-A-2 860 827 (EGLI) * Whole document * -----	1	
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
			F 01 D
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 11-10-1988	Examiner MCGINLEY C.J.
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons ----- & : member of the same patent family, corresponding document			

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